Name_____ Class_____ Date _____

Summary

11–1 The Work of Gregor Mendel

The scientific study of heredity is called genetics. Gregor Mendel used purebred pea plants in a series of experiments to understand inheritance.

Pea flowers have both male and female parts. Normally, pollen from the male part of the pea flower fertilizes the female egg cells of the same flower. This is called self-pollination. Seeds that come from self-pollination inherit all their characteristics from just one parent.

To carry out his experiments, Mendel had to prevent self-pollination. He did this by cutting away the pollen-bearing male parts and then dusting pollen from another plant on the flower. This process is called cross-pollination. The seeds that come from cross-pollination are the offspring of two different parents.

Mendel decided to study just a few traits, or characteristics, of the pea plants. He studied seven traits: seed shape, seed color, seed coat color, pod shape, pod color, flower position, and plant height.

First, Mendel crossed two plants with different characters, or forms, for the same trait. For example, one plant was tall and the other was short. Mendel used the seeds produced by this cross to grow plants. These plants were hybrids. Hybrids are the offspring of crosses between parents with different traits.

To Mendel's surprise, the hybrid plants looked like only one of the parents. He concluded that each trait was controlled by one gene that occurred in two different forms. The different forms of a gene are called alleles. Mendel formed the theory of dominance. He concluded that some alleles are dominant, while others are recessive. Whenever a living thing inherits a dominant allele, that trait is visible. The effects of a recessive allele are not seen if the dominant allele is present.

Mendel wanted to know what happened to the recessive allele. He allowed his hybrid plants to self-pollinate. Some of the plants that were produced showed the recessive trait. The alleles responsible for the recessive characters had not disappeared. Before, the dominant allele had masked the recessive allele, so it was not visible. Mendel concluded that the alleles for the same trait can be separated. He called this segregation. Alleles segregate when gametes are formed. Each gamete carries only one copy of each gene.

11–2 Probability and Punnett Squares

Mendel used the principles of probability to explain his results. Probability is the likelihood that a particular event will occur. Probability can be used to predict the outcome of genetic crosses because alleles segregate randomly. The gene combinations that might result from a genetic cross can be determined by drawing a Punnett square.

In a Punnett square, alleles are represented by letters. A capital letter represents the dominant allele, and a lowercase letter represents the recessive allele. Organisms that have two identical alleles for a particular trait are called homozygous. Homozygous organisms are true-breeding for a particular trait. Organisms that have two different alleles for a particular trait are called heterozygous. Heterozygous organisms are hybrid for a particular trait.

The physical traits of an organism make up its phenotype (for example, height). The genetic makeup of an organism is its genotype (for example, *TT* or *Tt*).

One important rule of probability is that probabilities predict the average outcome of a large number of events. They cannot predict what will happen in a single event. The more organisms examined, the closer the numbers will get to the expected values.

11–3 Exploring Mendelian Genetics

Mendel wondered whether genes that determine one trait have anything to do with genes that determine another trait. He wanted to know, for example, whether the gene that determines seed shape affects the gene for seed color. To answer this question, he did an experiment. He crossed plants and recorded two traits—seed shape and seed color.

Mendel found that the gene controlling seed shape did not affect the gene controlling seed color. Mendel concluded that genes can segregate independently, or undergo independent assortment, during gamete formation.

Not all genes show simple patterns of dominant and recessive alleles. In incomplete dominance, one allele is not completely dominant over another. In codominance, both alleles contribute to the phenotype. Many genes have more than two alleles and are said to have multiple alleles. Polygenic traits are traits controlled by two or more genes.

The characteristics of any organism are not caused only by its genes. Instead, characteristics are determined by the interaction between the genes and the environment.

11–4 Meiosis

According to Mendel, living things inherit a single copy of each gene from each of their parents. When gametes are formed, these two copies are separated.

Gametes are made during meiosis. In a complex process, the number of chromosomes in each cell is cut in half. The chromosomes are different from one another and from the parent cell.

There are two stages in meiosis. During the first stage, the DNA in special cells in the reproductive organs is copied. The cells then divide. Two cells are formed. These cells are different from each other and different from the parent cell. In the second stage of meiosis, the cells divide again. This time, their DNA is not copied first. Four daughter cells are produced. Each cell contains half the number of chromosomes of the original parent cell.

In male animals, the gametes produced by meiosis are called sperm. Some plants also have sperm cells. In females, meiosis produces one large reproductive cell and three smaller cells. In animals, the larger reproductive cell is called an egg. In some plants, it is called an egg cell. The three smaller cells produced during meiosis are called polar bodies. They do not participate in reproduction.

Meiosis is very different from mitosis. Mitosis makes two cells that are exactly alike. The cells are also exactly like the parent cell. Meiosis, however, produces four cells. Each of the cells has only half the number of chromosomes of the parent cell. The cells are genetically different from one another.

11–5 Linkage and Gene Maps

Some genes are almost always inherited together. These genes belong to the same linkage group. A chromosome is a group of linked genes. It is actually the chromosomes that assort independently during gamete formation, not single genes.

The location of genes can be mapped to a chromosome. The rate of crossover events is used to find the distance between genes on a chromosome. The farther apart two genes are, the more likely they will be separated by a crossover event.